NASA Aeronautics Competition: 2006-2007 Academic Year, University Division

Fundamental Aeronautics: Challenges and Opportunities

Part of NASA's mission is to inspire the next generation of engineers, scientists, and explorers. This year, the competition offers college students an opportunity to try to solve some of the technical challenges facing real aeronautics projects. Technical challenges exist in four areas: Hypersonic flight, Supersonic flight, Subsonic Fixed Wing transport, and Subsonic Rotary Wing transport. Some of these challenges occur in Earth's atmosphere, others occur in space. To solve these complex problems, real world teams from public and private sectors collaborate. In the college competition, challenges may be more thoroughly examined by multi-disciplinary, multi-department teams. Where possible, such teams are encouraged.

Categories for entry:

Individual undergraduate students or a small team (10 or fewer): Write a well documented concise paper* that explains your design for a system that addresses at least one of the technical challenges (see below). Teams must have a student leader and at least one faculty advisor.

Larger team of undergraduate students (more than 10 students) and/or graduate students: Write a well documented concise paper* that explains your design for a system that addresses at least one of the technical challenges (see below) **AND** integrates all the necessary elements for a new transportation concept. Combination teams with undergraduates and graduates are permitted. Teams must have a student leader and at least one faculty advisor.

For graduate students: Multi-disciplinary Design, Analysis and Optimization. Write a concise paper* that communicates your validated ideas for analysis tools. The creation of practical designs depends on understanding and exploiting the interactions among all of the technology challenges. This requires the development of a flexible integration framework where variable fidelity analysis tools can be used in a *plug and play* fashion as determined by the type of problem examined. Teams must have a student leader and at least one faculty advisor.

Note: Reference documents for each of the four fundamental aeronautics projects can be found at http://aerospace.nasa.gov/programs_fap.htm

*Paper for all categories is limited to a 25-page report (page limit excludes ancillary material, references, and appendices).

Technical Challenges:

Innovative Configurations for High Mass Martian Landing

Designs are needed for innovative entry descent and landing (EDL) systems to enable the landing of Martian exploration systems with up to a two order of magnitude increase in mass compared to recent landers. These systems must be landed with much greater position accuracy as well. The new systems must address the key elements of EDL including hypersonic reentry and deceleration, supersonic deceleration, subsonic terminal deceleration and precision landing.

Hypersonic Flight

Innovative hot structure attachment concepts: Innovative methods and materials are required to attach hot structure (typically 3000F) to inner structure that must be no hotter than 250-350F. The structural concept must efficiently transfer mechanical load without transferring heat load and do so at low weight and cost.

Efficient shapes for access to space: Innovative shapes are required to improve the efficiency of air breathing vehicles for access to space.

Supersonic Flight

Supersonic Cruise Efficiency: To achieve economic viability, supersonic cruise civil aircraft need to demonstrate unprecedented levels of cruise efficiency, without excessively penalizing performance in other speed regimes. Cruise efficiency, including airframe and propulsion efficiency, needs to be increased by a combined total of approximately 30% in order to provide the required supersonic cruise range.

Materials that are Light Weight and Durable at High Temperature: Significant reduction in high temperature airframe and propulsion system weight is a key element to achieving practical supersonic flight. New material and structural systems must achieve these weight targets without affecting life or damage tolerance. Overall, a reduction on the order of 20% of structural and propulsion system weight is required.

Sonic Boom: In order to achieve maximum utility, supersonic overland flight must be achievable. This requires that the aircraft must be designed and operated so that no unacceptably loud sonic boom noise is created over populations. It is estimated that a reduction of loudness on the order of 30 PLdB relative to typical military aircraft sonic booms will be required

Subsonic Fixed Wing Transport

Design a short take off and land commercial transport system that can carry 125-150 passengers a distance of 500 nmi at M=0.8 or better using 2500 foot runways. Also included in the design should be technology designed to do one or more of the following:

- lower noise levels (stage 3 -52db cum)
- lower landing-take-off nitrous oxide emissions (80 percent reduction from 1996 ICAO standard)
- improve cruise performance (using 25 percent less fuel than current transports of the same size

Subsonic Rotary Wing Transport

Highly Reliable and Efficient Rotorcraft Propulsion: Design a modular rotorcraft for commercial passenger transport (airliner style) that would permit on-the-tarmac servicing. For example, the modularity could enable swap-out of the primary drive-train with minimum tooling and lift equipment, allowing for off-line servicing without disrupting aircraft availability.

Noise Reduction from Improved Understanding of Rotorcraft Acoustics: Design an advanced helicopter (as compared to current helicopters) specifically tailored to maximize noise reduction from a systemic perspective.

Improved Operating Environment from Advancements in Rotorcraft Structures and Materials: Design advanced crashworthiness and survivability systems for civilian medical evacuation helicopters.

Innovations from Improved Understanding of Rotorcraft Aeromechanics and Fluid Dynamics, examples of what these innovations might enable:

- Viable design of a large commercial V-22-like tilt rotor aircraft. Address vehicle performance in terms of passenger capability, range, cruise speed, etc. Analyze and discuss design trades leading to the final design. Identify critical innovations to resolve aeromechanics technologies/issues.

- Urban evacuation. What innovations would enable a significant evacuation/rescue capability from urban centers during natural and manmade disasters? For example, students could design something to overcome the challenges faced in the post-Katrina rescue effort.

Due Dates:

Notice of intent* January 19, 2007

Final entry is due on or before April 23, 2007

*A notice of intent tells NASA that you plan to enter the competition in a specific category. This helps us to determine how many reviewers we need for the final entries.

The notice should be emailed and should include the following details:

To: e.b.ward@larc.nasa.gov
Subject line: University Competition

Body of message contents:

student leader's name(s)
faculty advisor's name
name of college
name of department(s) participating
location of college (city and state and country if outside the US)
level of study for all participating student(s) (freshmen undergraduate through final PhD)
email and phone number for student lead
email for faculty advisor

Eligibility:

Any US citizen enrolled in an accredited college or university in the US or its territories is eligible to enter the competition. International students, either in the US or elsewhere, may enter but will not be eligible for certain prizes. Trophies and certificates will be awarded to each winner, regardless of citizenship. Students who are receiving NASA funds for research projects or who are working on a NASA funded project for a faculty member should disclose this information in their entry packet. Failure to do so may result in disqualification for the student and/or the entire team.

Each entry must be sponsored by a supervising or advising faculty member. This means that the faculty member reviews and approves the student entry before it is submitted to NASA. The faculty should also affirm that the students did the research and writing themselves and that none of the students are receiving NASA funds for a research project in any way related to the competition.

Internship Eligibility

NASA has several programs that provide internships for US Citizens. Internship programs bring the students to a NASA facility to work directly with a NASA mentor for the summer or during part of an academic year. For a list of all the available internship opportunities, please consult the main NASA web site or the NASA Education web pages at each of the NASA field centers. Look for Student Learning Opportunities or similar search criteria. Most of the internship applications are due early in calendar year, but each program has its own set of application due dates.

For the aeronautics competition, if funds are available, paid summer internships may be offered to qualified student winners. If students would like to apply for these, a completed internship application, transcripts, and one-page resume will be required along with the final entry. Students may opt to apply for an internship through the normal NASA application process and simply inform the competition administrator of their application when the final entry is submitted. Summer internships normally begin in early June and conclude 10 weeks later in early August.

Resources:

Detailed reference documents and project contacts for each of the four aeronautics projects can be found at http://aerospace.nasa.gov/programs_fap.htm

Evaluation Criteria

Entries will be evaluated by representatives from each of the four NASA aeronautics Centers, including Ames, Dryden, Glenn and Langley.

Each entry will be judged on its own merit against a set of basic criteria. Entries will be scored on how well they have focused their paper and how well they have addressed all aspects of the problem they chose to address. In addition, scores will be assigned for each of the following: innovation and creativity; discussion of feasibility; baseline comparison with the relevant current technology, system, or design; and brief review of current literature relevant to their project. Award level entries will be well written, well organized, thorough and concise.

2006 - 2007 University Awards

All awards are subject to available funds. We expect to award cash prizes and student internships.

- Each participant will receive a certificate of achievement.

- Top scoring entries will receive trophies or similar NASA mementos.

- We hope to invite representatives from top teams to present their work at a NASA forum held during the summer of 2007. More information will be posted at a later date.

- Abstracts of the winning entries may be posted to NASA web sites.

The following is tentative and will be announced in greater detail in early 2007:

- Cash prize amounts will be on the order of $5000 for first place, $3500 for second place, $2000 for third place. In the case of a tie, prizes will be determined based on funds available. Non US schools are not eligible to receive cash awards.

- Student internships carry the stipend of the Center providing the stipend. For example, at NASA Langley in the summer of 2006, a 10 week summer internship had a stipend range of $4000 to $5000 depending on level of study and GPA of the student intern. Internship awards are for US citizens only and require a full 10 week on-site commitment of 40 hours per week. Normally the internships begin in early June and conclude in early August.

The competition is sponsored by the National Aeronautics and Space Administration Fundamental Aeronautics Program, Aeronautics Research Mission Directorate, NASA Headquarters, Washington, DC. The competition awards are administered by Christopher Newport University through a grant with NASA Langley Research Center, Hampton, VA.